Open Spectrum FAQ

version 1.1.1 [History]
1.20.03

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GO TO...

- A paper on Open Spectrum
- Discussion forum
- More links

By David Weinberger, with help

1. This sounds like a pretty geeky, technical topic. Why should I care?

Imagine that every American had the same access to the public airways as broadcasters do today.

Imagine everyone living within reach of a radio signal had the ability to communicate with everyone else.

Imagine rather than having to worry about how much "bandwidth" is enough, everyone had unlimited access to bits so that the size of what you communicate simply didn't matter.

You know the effect the Internet has had on how we live and work together? Multiply it by hundred.

Opening the spectrum would turn a federally-managed permissions system into an open market for ideas and creativity. The effects on our democracy and economy should not be underestimated.

2. What are the goals of supporting Open Spectrum?

1. To enable innovation in the wireless world by removing the roadblocks: regulations based on incorrect technical assumptions, and commercial interests afraid that innovations will loosen their control of markets.

2. To enable everything that can be connected to be connected, accomodating the exponential increase in wireless communications driven by the growth of pervasive and interoperable devices on the Internet.

3. What is spectrum?

"Spectrum" refers to the range of frequencies over which electromagnetic signals can be sent. That includes radio, television, wireless Internet connectivity, remote control toy race cars, and every other communication enabled by radio waves.

4. Who uses spectrum?

Everyone who uses a technology that connects without wires. That includes radios, TVs without cable, planes with radar, cell phones, portable phones, garage door openers, baby monitors... In short, if you live in the 21st century in a place with electricity or batteries, you are almost certainly a user of spectrum.

5. What is Open Spectrum (OS)?

An Open Spectrum policy would permit anyone to send signals across any range of spectrum without permission, with the minimum set of rules required to enable the success of a "wireless commons."

6. Is Open Spectrum a new technology?

Definitely not. It's a new approach to governance that incorporates a much more accurate view of the relationship between bits, their physical representations as electromagnetic waves in space, and our tools for manipulating signals (including the ability to build distributed, adaptive, interoperable communications architectures).

7. How much will Open Spectrum cost?

The infrastructure is already largely in place. The incremental costs will be quickly replaced by a dramatic drop in the cost per bit for businesses, end-users and the government.

In addition, the provisioning of every businessperson, family, content creator and inventor with unlimited access to bits and easy connection to all others will create a market for innovation that cannot be overestimated.

8. What's the current spectrum policy?

The FCC has implemented a system where parts of the spectrum are allocated on either an exclusive or shared basis. If 'exclusive', then the right to use this spectrum is conveyed by a license. The terms of this license give its holder the right to use this block of spectrum for the term of the license. If 'shared', then access to the spectrum is shared by many users, who are either given a license, or who use equipment to access that spectrum which has been certified by the FCC. With this type of access, the FCC specifies some 'rules of the road' so that interference between the sharing partners is minimized.

This method of sharing the radio spectrum has come to be known as 'command and control.'

9. How did we get to the current policy?

The policy began in 1912 as a reaction to the failure of the Titanic's help signals. The Radio Act of 1912 enabled the Secretary of Commerce to license radio frequencies but did not give him the right to reject applications. By the 'Twenties, enough broadcasters had jumped in that the technology of the time produced significant interference among signals, a situation the Radio Act of 1927 addressed by declaring the "ether" to be a publicly owned resource that should be doled out in ways that meet public interests. In The Great Lakes Broadcasting case (1929), the Federal Radio Commission (later called the FCC) said that "public interest" means the broadcasts meet the "tastes, needs, and desires of all substantial groups among the listening public . . . in some fair proportion, by a well-rounded program, in which entertainment, consisting of music of both classical and lighter grades, religion, education and instruction, important public events, discussions of public questions, weather, market reports, and news, and matters of interest to all members of the family find a place..." Thus did the federal government become the arbiter of what constitutes worthwhile content. [Source]

The FCC itself was founded as part of the 1934 Telecommunications Act.

10. What's changed that now makes Open Spectrum plausible?

Technology has evolved since the Titanic went down. The laws and policies in existence today address limitations of the technology of the early 1900's.

Interference — which we've treated as as law of nature — is an artifact of the way radio were designed 100 years ago. If interference isn't an issue, then the reasons we started to license spectrum become irrelevant.

In fact, the core premise that has undergirded our spectrum policy has dissolved: There is no scarcity of spectrum. It does not need to be doled out. On the contrary, there is an abundance of spectrum.

Our current policies prevent us from benefiting from this abundance.

11. Technologically, what's changed to make OS plausible?

When radios were invented, they were designed to do one thing only: receive as cheaply as possible. They were much less capable of processing the signals they were receiving. Our electronic and information processing technologies have advanced considerably since then:

Today's receivers are capable of separating signal from noise well enough that they don't need "buffer zones" around the frequency they are receiving.

Receivers and transmitters are smart enough to be able to switch frequencies as a particular band gets more congested. As with allowing cars to change lanes on the highway, this dramatically increases overall throughput.

"Software-defined radios" (SDR) can do more with a signal than decode it as sounds to be played through speakers. SDRs can be programmed to treat these signals as encoding any conceivable type of data.

12. What is interference?

Interference is a metaphor. And it is a misleading one. Everyone knows that waves don't actually interfere with one another. How do we know this? Try talking while someone else is talking. Your sound waves don't garble the other person's. Both sets of sound waves arrive intact. Of course, it can be hard to understand what either person is saying. But that's not because the sound waves have been deformed the way talking through a pillow or a kazoo deforms the them. Instead, the problem is with our "software's" inability to interpret the sound waves.

Likewise with radio waves. The garbling of signal that prevents good reception isn't due to interference but to the inability of the receiver to separate signal from noise. But modern receivers are far better able to do that. As a result, we no longer need a federal policy that is the equivalent of licensing only one person to talk at a time.

13. Interference is a metaphor??? Then why is my car's radio so lousy?

Interference does not exist as a thing in itself. It only becomes interference if the receiver can't isolate the information in a complex signal. It's the processing ("detection" or "demodulation") that gets confused, and the confusion is highly specific to the particular detector.

For example, there are 3 or 4 types of FM demodulators that are standard. Each one has its own way to extract information from an FM modulated signal, and each one reacts to excess signals differently. But one can design an FM demodulator that is highly robust to all kinds of other signals.

This is not to say that we should. But surely over a period of 50 years, without regulation, we would have migrated many of our communications systems to ones that work much better and cooperate much better. Regulation has protected weak systems far too long from competition and innovation.

Interference *is* a metaphor. It cannot be precisely defined technically without fully specifying a particular technology frozen in time, and in any case has nothing to do with the legal definition given by the FCC.

14. How much more "bandwidth" would Open Spectrum provide?

This question makes an unwarranted assumption. It thinks that spectrum is like a natural resource: there's just so much, so it needs to be apportioned wisely and fairly. In fact, neither spectrum nor information are things with fixed sizes. For example, as compression algorithms get better, more information fits into fewer bits. And as more people join a wireless network, there can be a *cooperative gain* effect whereby the network actually increases its capacity.

To take just one example, a recent New York Times article reported on a new technology, called BLAST by its inventors at Bell Labs, that uses "the reflections that plague current wireless systems" to expand the capacity "'far, far in excess of what people were thinking of.'"

15. Is unlicensed spectrum the same as Open Spectrum?

No. Unlicensed spectrum refers to spectrum for which the FCC doesn't issue a specific license to a user, but instead certifies equipment that may be used in a segment of spectrum designated for shared use. For example, the 2.4 GHz band is such a area, which is why you may have noticed that that's the only place where innovations such as Wi-Fi and long-range cordless phones operate. (The lesson: opening spectrums enables innovation.)

16. Why wouldn't making more spectrum unlicensed do the trick?

While unlicensing more spectrum would certainly help the development and deployment of new technologies, it would not allow the open and ubiquitous access that could transform our economy and democracy. Merely unlicensing some more spectrum keeps *us in a permission economy.*

17. Why not be incremental about this and open up some spectrum but not all of it?

The push for increasing the amount of unlicensed spectrum tacitly accepts the current metaphors and paradigms. The metaphors are outdated and the paradigms legitimize anti-democratic power structures that give permission and privilege to a few economic giants. We should instead be reframing the question. And once the question is reframed, we believe that Open Spectrum is the obvious answer.

18. So everything would change overnight?

No. If Open Spectrum is accepted as a policy, open market forces will bring about change at the pace the market finds acceptable. As fast as newer, better technology can be deployed to implement legacy functions, those legacy functions will go away due to competition.

But the market has to be open if this is to work. For example, that means that we should be able to send "TV" broadcasts over the Internet and wireless networks, without attempts by content owners to limit the path by which it gets to users.

19. What about security?

Security should not be built into Open Spectrum, any more than it is built into the Internet. It will be more secure if it is done at the "ends" of the communication, not in the middle. (This is the point of the "End-to-End" argument.) In short: if you want security, encrypt your transmissions.

20. Should the military and/or emergency services have their own protected frequencies?

First, we believe that the frequencies that the military uses for communications, radar, etc. would be as secure and interference free as any other set of frequencies in a world with Open Spectrum. This is a question that needs to be argued on its scientific merits, free of scare-mongering.

Second, assigned frequencies have their own vulnerabilities. One of the basic technological enablers of the Open Spectrum approach is some form of "frequency hopping" that opportunistically moves transmissions into the most accessible bands. This approach was invented during World War II (and, surprisingly, Hedy Lamaar is one of the two names on the initial patent) to get around the fact that a radio-controlled torpedo could be jammed if its assigned frequency were detected. If the military wants to own its own slice of spectrum because allowing others onto it might cause "interference," what would keep terrorists from purposefully causing the problem?

We have all been learning, across the board, that open, distributed networks are far more secure and robust than hard-wired, centralized ones. That lesson applies to spectrum as well.

21. What is Ultra-Wide Band?

It's a technology that transmits complex waves across huge swaths of frequencies in short bursts. It transmits in such a way that it has a minimal impact on other users of the frequency bands that it crosses. This effect is known as "'underlay."

22. What is the relationship of broadband Internet and Open Spectrum?

"Broadband" usually refers to increasing the size of the pipe through which the Internet can pump bits to and from an end user. Big pipes are better than little pipes, but Open Spectrum can connect people where putting pipes is prohibitively expensive and constraining. Since installing new cable typically costs hundreds of dollars per end point, wireless solutions are naturally preferable in almost all cases.

Wireless technologies based on open interconnection and cooperative networking can provide most or all the

benefits of pipes, without the costs and permissions needed to deploy wires.

23. What is Software-Defined Radio?

You can view a SDR either as a radio with a computer attached to it or a computer with a radio attached to it. Rather than simply assuming that the information coming via radio waves encode sounds, a SDR can treat the information any way that it's programmed to. This makes radios much smarter and it makes computers part of a ubiquitous network of unimaginable capacity.

24. What sort of applications are we likely to see if spectrum is made open?

Some applications are obvious and predictable: more end user creation of high definition TV works, more video-on-demand. But the real importance is that we will see an outburst of innovation as people and businesses realize they can reach a broad range of people with two-way applications that rely on the rapid movement of large amounts of data.

What if we were all connected to one another wherever there's a radio signal? What if we could communicate whatever and whenever we want? What would we build? How would our economy grow? How would our spirit bloom?

25. Is the FCC seriously looking at opening the spectrum?

Michael Powell in a speech in October 2002 said "we are still living under a spectrum 'management' regime that is 90 years old. It needs a hard look, and in my opinion, a new direction....Modern technology has fundamentally changed the nature and extent of spectrum use. So the real question is, how do we fundamentally alter our spectrum policy to adapt to this reality?" Citizens "deserve a new spectrum policy paradigm that is rooted in modern day technologies and markets."

26. Won't the broadcasters and the military stop this?

They may try. But they don't hold their licenses for their sakes. They hold their licenses because it was decided — correctly in our view — that the airwaves are owned by all of us. Licensing spectrum brought the public much good when the technology of the day required putting limits on who can connect. Today's technology is erasing those limits. The new public good is access and connectedness.

27. What effect will this have on broadcasters?

They will continue to have tremendous value as producers of content people want to see and listen to. They will lose the advantage granted to them that all others have been excluded from the airwaves.

Smart broadcasters will realize that there is huge potential economic value to being the holder of valued content in an age of connectedness. It is up to them to figure out how to deliver that value.

28. Does this require everyone to get new radios and TV sets?

No. Existing technologies will continue to work. They will be replaced by customers as they — we — realize the benefits of the new technology.

29. Will I still be able to watch *The West Wing?*

Yes. The current broadcasters will continue to provide content we care about, and we will continue to receive their broadcasts on the technology of today and tomorrow.

But remember, Open Spectrum isn't just about broadcasting. It's about connecting all of us so that we can talk, play, argue and laugh together ... and create our own content that may be better than what we currently get from the broadcasters.

30. Is Wi-Fi an alternative to Open Spectrum?

No. The Wi-Fi specification enables networks to use slices of spectrum, just as radios and garage door openers do. Open Spectrum would open up all of spectrum for Wi-Fi and other applications.

31. What bearing does this have on the telephone networks?

The current telephone networks are already being challenged by the Internet. This would intensify that challenge. It would also dramatically solve the problem of the "last mile," i.e., providing "broadband" connectivity to households and offices.

32. How does this fit with the FCC's exploration of unlicensed spectrum to connect rural areas?

The FCC has recently asked for comments on the idea of using unlicensed spectrum to provide Internet connectivity to rural areas. This is attractive because running cable out to distant areas is expensive and in some instances environmentally disruptive. But Open Spectrum would solve this problem in a single blow without facing the probability that it will be obsolete in a few years.

33. Who wrote this FAQ?

David Weinberger [mail] did most of the wordsmithing, drawing on content from Jock Gill [mail], Dewayne Hendricks [mail], and David P. Reed [mail].

34. Where can I learn more?

Here are some links. We'd be happy to hear about more.

Why Open Spectrum Matters, by the people who wrote this FAQ
David Reed's page on Open Spectrum
"Societies of Cooperating Cognitive Solutions" by Jock Gill
"Open Spectrum: The New Wireless Paradigm" by Kevin Werbach
The FCC Spectrum Policy Task Force's page
Lawrence Lessig's Stanford resource page
Lawrence Lessig's conference on spectrum policy
Prior Restraint by Bob Frankston
Net Gains: Will technology make CBS unconstitutional? by Yochai Benkler and Lawrence Lessig

35. Where can I discuss this FAQ?

There's a discussion board here.

Version History

01.19.03: v1.0
01.20.03: v.1.1
01.20.03: v.1.1